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A REVIEW OF THE SCIENTIFIC FOUNDATIONS AND ASSOCIATED INJURY RISKS OF EARLY SOCCER SPECIALISATION

RUNNING TITLE

Early Soccer Specialisation and Injury Risk

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ABSTRACT

Early specialisation is characterised by formal participation in a single sport at the exclusion of others. Limited data are available to support this approach in the development of soccer players who attain elite status later in life. Of growing concern is the associated increased risk of injury and suggestions that single sport specialisation is a risk factor independent of age, growth, biological maturation and training volumes In the United Kingdom, elite soccer organisations have recently adopted an early sport specialisation approach following the introduction of the Elite Player Performance Plan. A key tenet of this programme is increased opportunities for training through a marked rise in the specified on-pitch hours per week. The accumulation of high training hours may be less of a relevant marker for success, and the impact of such a significant increase in training volume for young athletes who are experiencing a range of growth and maturational processes is currently unknown. This critical commentary includes an evidence based discussion of the effectiveness of early sport specialisation and the potential injury risks associated with such programmes placing a specific focus on elite male youth soccer players. Available data indicate that modifications to the existing EPPP framework could enhance player development and reduce injury risk. Proposed alterations include reduced volume of soccer specific training at key stages of growth and maturation and guidelines for the provision of a greater variety of physical activities that are integrated within other programme components.

INTRODUCTION

A common dilemma in developmental sport has centred on the efficacy and effectiveness of child athletes applying deliberate focus to just one sport at the expense of participating in a range of activities (Baker, 2003). The path of early sport specialisation has been recognised as early age involvement in one chosen sport during the period of early to middle childhood (up to age 13 years) with no subsequent participation in the other sports or activities available (Moesch et al., 2011). Specifically, this has included talent identification/development programmes focused on the attainment of professional sports or Olympic success, which in turn has increased the frequency of high volume, intense competitive activities that are highly structured and focused on a single sport without sufficient time for rest and recovery (Bergeron et al., 2015).

Historically, this has been applied in sports such as gymnastics and diving due to the added advantage of a smaller body mass for rotational movements. The application of systematic training in a single sport from a young age is based on the goal of attaining elite status due to increased exposure and practice (Malina, 2010). Early research suggested that mastery and elite performances in a range of activities was achieved by accruing more deliberate practice time (Ericsson, 1993); however, this research has often been incorrectly interpreted (Ericsson, 2013) and there is a paucity of literature to support this notion in sporting activities. For example, Vaeyens et al. (2009) reported that no evidence currently exists to confirm earlier exposures and greater volumes of sport-specific training are associated with heightened success later in their sporting career.

The risks associated with specialising early within a given sport include the potential for increased injury risk; social isolation and burnout (Malina et al., 2010; Lloyd et al., 2014). Furthermore, a recent position statement from the American Medical Society of Sports

Medicine concluded that early sport specialisation may not lead to long-term sporting success and may increase the risk of overuse injury and burnout (Di Fiori et al., 2014). The commencement of formalised intensive training during the pre-pubertal years in one chosen sport by excluding others imposes demands on young children that are exhaustive and entail high psychological pressures reflective of those often undertaken by adults (Borms, 1986). This may increase the likelihood of withdrawing from their chosen sport due to injury or burnout (Gould et al., 1996; Wall and Cote, 2007). Early sport specialisation has also recently been identified as an independent injury risk factor even after accounting for age and hours of total training and competitions completed each week via the use of multivariate regression modelling (Jayanthi et al., 2015). The increased injury risk for youth athletes who engage in a single sport could be attributed to repeated exposures of submaximal loading on the musculoskeletal system (Stein and Michelli, 2010; Di Fiori, 2014), whereby, sufficient time for recovery and adaptation or variety in movement patterns in not provided (Di Fiori et al., 2014). There is a paucity of literature to confirm this notion in soccer; however, available evidence suggests that both athletes and coaches should proceed with caution before adopting an early sport specialisation approach.

In the sport of soccer, an inherent risk of sports-related injury exists where a concomitant increase in a child's age results in greater exposures to repetitive loading patterns that occur in training and competitions, (Hogan and Gross, 2003). Recent investigations have also reported that youth male soccer players display a heightened risk of overuse and sport-related injuries at various stages of growth and maturation, specifically during the year of peak height velocity (van der Sluis et al., 2014; van der Sluis et al., 2015). Possible mechanisms which contribute to increased risk of injury during this period include changes in joint stiffness, and aberrant movement patterns such as high knee abduction moments (Ford et al., 2010). Therefore, practitioners should be cognisant of the potential negative implications of early sport specialisation and avoid repeated exposures to solely sport-specific skills, which may increase injury risk and limit motor skill enhancement. Also, an understanding of physiological changes associated with key developmental periods during a child's growth and how this effects movement skill and injury risk is required to effectively devise long-term soccer development programmes. In the United Kingdom, elite soccer organisations have recently adopted an early sport specialisation approach following the introduction of the Elite Player Performance Plan (EPPP, 2011). This programme requires an increased volume of on-pitch training hours per week in comparison to previous guidelines (EPPP, 2011). The accumulation of high training hours appears to be an inaccurate measure of determining which players achieve elite professional status later in their career (Haugaasen et al., 2012), and may impose a greater risk of injury (Brink et al., 2010; Jayanthi et al., 2015); however, the impact of this programme is currently unknown. The two key aims of this article are to; 1) review the available literature to determine the effectiveness of early sports specialisation, 2) outline the potential injury risks associated with early sport specialisation with a specific focus on elite male youth soccer players.

Is Early Sport Specialisation Effective?

Cumulative findings from the available literature suggest that in most sports, athletes who experience greater diversification in their younger years increase their chances of sporting success later in life (Jayanthi et al., 2012). For example, athletes attaining elite status intensified their involvement with their specialist sports later than non-elites (Lidor and Lavyan, 2002). This has been confirmed in ice hockey (Soberlak and Cote, 2003), tennis (Carlson, 1988), and swimming (Barynina and Vaitsekhovski, 1992); however, when interpreting the findings from these studies it should also be considered that regular participation in their primary sport was also reported during childhood. More recent reports have revealed that elite adult athletes commenced intensified training schedules later than those who were near elite (Moesch et al., 2011). Retrospective analysis of the accumulation of training also identified that near elites had undertaken more hours by ages 9, 12 and 15 years, whereas, the elite group accumulated greater training hours by age 21. This suggests elite adult athletes specialise in their chosen sport later than their non-elite counterparts. Also, a consistent finding from the available literature is that elite adult athletes also played a greater variety of other sports during their developmental years than non-elites (Jayanthi et al., 2012). More diverse sports participation has also been reported to increase gross motor coordination and lower body explosive strength in the form of a standing broad jump versus young boys who specialised in a single sport (Fransen et al., 2012). This is likely as a result of increased exposures to a greater number of physical, cognitive, affective and psychosocial environments and thus, the development of a broader range of skills that are required for sport specialisation during adolescence (Côté et al., 2009; Fransen et al., 2012). However, practitioners should be cognisant that there is currently a lack of available evidence to describe the mechanisms underpinning the effects of greater diversification in the developmental years and longitudinal research is needed to more clearly examine the causal relationship between greater sports diversification and enhancements in motor skill and physical fitness development (Fransen et al., 2012).

Available data to confirm the effectiveness of early sport specialisation in soccer are limited. A review of literature highlighted that the age at which participation commenced appears to range between 5 and 14 years of age (Haugaasen and Jordet, 2012). Some studies have reported that elite English players started earlier than their non-elite peers (Ward et al., 2007), whereas, other studies reported no difference in starting age in players from Belgium and Holland (Helsen et al., 2000; Huijgen et al., 2009). Participation differences between players classified as either recreational, formerly-elite, or those still competing at the elite level have also reported the importance of unstructured soccer play activities (Ford et al., 2009). In both elite groups, players averaged more cumulative hours than recreational players, but no differences were identified in soccer practice, competition or other sporting activities prior to age 12. However, the players progressing to professional status accumulated more unstructured *'play'* hours than their ex-elite counterparts. Thus, while early specialisation is not recommended, the importance of practice and play in soccer type activities from a young age has been shown to contribute to the attainment of elite performance in soccer (Ford et al., 2009). This supports the early engagement hypothesis, whereby children who achieve expert status later in life undertake more 'play' activities in their chosen sport (Côté et al., 2007), and this has been further described in German professional soccer players with up to 86% of soccer type activities comprised of a non-organised structure (Hornig et al., 2014). This type of activity may be important for developing a range of skills including anticipation and decision making (Bell-Walker & Williams, 2008), and psycho-social aspects such as motivation and enjoyment (Côté et al., 2007). Thus, authors have proposed the importance of early engagement during the childhood years rather than structured repetitive practice as this may lead to greater skill levels later in their career (Ford et al., 2009). It should also be considered that successful application of long-term athlete physical development approaches are largely determined by education and quality instruction from appropriately qualified coaches highlighting the importance of coach-athlete interaction from an early age (Myer et al., 2011; Lloyd and Oliver, 2012). A more recent study using Portuguese futsal players reported that elite players dedicated themselves to the sport earlier than their non-elite counterparts (Serrano et al., 2013). These results are in conflict with an investigation that assessed the contribution of diverse participation towards the attainment of elite youth and senior professional status in soccer players (Haugaasen et al., 2014). A retrospective questionnaire was utilised and reported the amount of time spent partaking in sports other than soccer and their perceived contribution of non-soccer related activities. No significant differences were shown between the engagement history of professional and non-professional players. However, participating in similar sports was rated as important to compliment the development of soccer skills.

There is also conflict within the available literature regarding the requirement for accumulation of soccer practice hours in becoming an elite adult player (Haugaasen et al., 2012), which is a fundamental principle of recently adopted youth soccer development programmes (EPPP, 2011). Case histories of players from English Premier League academies identified a greater volume of practice than a sub-elite control group (6500 hours versus 4990 hours) (Ward et al., 2007); however, the number of years of participation displayed minor differences (11 versus 10.5 years respectively). Furthermore, the subjects in this study were elite youth players; therefore, these data do not support the application that greater accumulation of training hours present in elite academy players increases the likelihood of achieving elite status as a senior professional. Other studies have also shown no differences in accumulated soccer practice time between elite and sub-elite players (Koslowsky and Da Conceicao Bothelo, 2010).

The age at which accumulated practice differentiates between elite and non-elite players is also a point of contention. Using a retrospective questionnaire, the majority of Portuguese national team players (90.5%) have been reported to undertake significantly greater soccer-specific practice by age 10 years (Leite et al., 2009). Conversely, Dutch professional players were reported to partake in an additional hour per week of soccer-specific practice from age 14 years (Huijgen et al., 2009). Although not directly linked to early sport specialisation, the period of time for accumulation should also be considered, because prior research has failed to show significant differences in accumulated practice time between elite and sub-elite players until 10 years into their adult careers (Helsen et al., 1998). Variations reported within the aforementioned literature could be due to recall bias which can occur with both long and short term retrospective reporting (Junge and Dvorak, 2000).

Currently, there are inconsistencies within the available literature as to the effectiveness of early soccer specialisation in developing elite adult professional players, which may be attributed to high drop-out rates (Haugaasen and Jordet, 2012); a key factor affecting continued participation (Vaeyens et al., 2009). Opportunities to partake in unstructured play and a wider range of sporting activities appear to be useful and should be encouraged. Engaging in intensive specialised soccer training with high levels of structure does not guarantee the likelihood of higher performance levels later in life but may lead to an increased risk of overuse injuries. Also, data available from Portuguese national athletes (including soccer players) showed that the path to expertise were non-uniform, which reflects the complexity of skill acquisition (Leite et al., 2009). Furthermore, in former Swiss professional soccer players, although all players retrospectively reported above average volumes of in-club training, some showed above average participation rates of informal soccer outside the club, whereas, others described greater than average activity in other sports (Zibung and Conzelmann, 2012). Cumulatively, while not always consistent, the existing literature indicates a more diverse approach to sports participation is preferable.

Injury risk associated with early soccer specialisation

The incidence of traction apophyseal injuries in youth athletes warrants consideration. Such injuries are particularly prevalent in soccer between the ages of 11-14; with peak incidence occurring in males for the under 13 and under 14 age groups (Price et al., 2004). A delay between growth in muscle length and cross-sectional area has been reported (Xu et al., 2009) and may result in altered neuromuscular control, which requires accurate sensory input and appropriate motor responses to maintain correct alignment in response to rapid adjustments of the bodies centre of mass that can occur during cutting and landing movements (Lephart et al., 2002; Zazulak et al., 2007). Available data in female athletes show that this interaction can affect dynamic stabilisation, leading to aberrant patterns of neuromuscular control (Hewett et al., 2004; Ford et al., 2010). The presence of these musculoskeletal growth lags following the onset of a growth spurt up to, and around the period of peak height velocity (PHV), needs to be considered in the management of male youth soccer players. During these sensitive periods of growth, players should be monitored and training volume and/or intensity may need to be adjusted to reduce the risk of apophyseal and overuse type injuries.

High exposures to the repetitive patterning of soccer activities such as kicking from a young age may also lead to morphological adaptations. An example is radiographic changes and the development of Cam-Type deformity combined with femoral acetabular impingement in male youth soccer players (Agricola et al., 2012; Tak et al., 2015). A recent finding is that a cam deformity in soccer players only develops during the period of skeletal maturation when the proximal femoral growth plate is open (Agricola et al., 2014). Although not all studies have reported significant associations between skeletal immaturity and a higher risk of cam deformity (Johnson et al., 2012), there is a high prevalence in young adult males who participate in soccer activities (Johnson et al., 2012; Agricola et al., 2012; Tak et al., 2015). This risk of cam deformity increases in males who played intensive soccer versus controls (Agricola et al., 2012; Tak et al., 2015). Specifically, a cam deformity appears to be less likely to develop in youth players who do not participate in frequent practice (defined as ≥4 times per week) prior to 12 years of age. This could be linked to increases in growth hormone and insulin growth factor-1 in boys aged between 12-14 years, increasing bone responses to hip loading (Ferguson and Patricios, 2014). Confounding this, accumulated years of practice demonstrate weak associations with the presence of the specified morphological adaptations; reducing the volume of soccer-specific training and competitions during this period may be warranted (Tak et al., 2015). Therefore, the intensity, type, duration, and frequency of training and competition loads should be adjusted during skeletal growth to minimise the risk of developing groin pain, limitations in hip function and osteoarthritis. Also, participation in a wider range of diverse sports and activities will increase their movement variability and alter the point of force absorption/production, stressing a greater range of anatomical structures which in turn may provide a more even distribution of stress/adaptation and reduce the risk of overuse injury.

There is currently a paucity of literature available to examine the relationship between workloads and injury incidence in elite male youth soccer players. Gabbett et al. (2012) identified that of the few studies available; an increased external training load as measured by a global positioning system (GPS) resulted in heightened injury rates and longer training durations was associated with a greater incidence of illness. The authors highlighted that undertaking greater workloads may be necessary in elite sport to stimulate an adaptive response but this increases injury risk. The physical stress associated with training has also demonstrated relationships with injury in elite male youth soccer players. Measured across a period of two seasons, physical stress was related to both injury and illness (range odds ratio, 0.56 - 2.27) (Brink et al., 2010). Specifically, increased exposure has been identified as the most important risk factor for injury in high school athletes (Rose et al., 2008), and a training threshold of more than 16 hours per week has been associated with a significantly increased risk of injury (Rose et al., 2008). This volume of intensive, specialised sports participation was also identified by Jayanthi et al. (2015), whereby, young athletes who completed more hours of sport per week than their age in years, or whose ratio of organised sports versus free play time was >2:1, were at a greater risk of serious overuse injury (odds ratio, 1.87, P < .01). Risk was also greater in youth athletes who undertook highly specialised sports practice suggesting this is a risk factor for serious overuse injury, independent of age, growth, biological maturation and training volumes.

In summary, the available literature suggests that engaging in soccer specialisation programmes from an early age does not guarantee success or predict the achievement of elite status later in their career (Vayens et al., 2009; Haugaasen and Jordet, 2012).). From a population of approximately 10,000 aspiring players, data reported by the Professional Footballers Association (PFA) has estimated that <1% of young boys who are involved in soccer development programmes establish a career as a professional player (Green, 2009). Furthermore, data from the PFA indicate that of adolescents entering full-time scholarship programmes after leaving school, 50% will no longer be involved in football two years later, and at age 21, the attrition rate rises to >75%. There is also a considerable risk of injury in early soccer specialisation programmes (Brink et al., 2010; Agricola et al., 2012; Tak et al., 2015) and reports in other sports of high athlete attrition due to burnout (approximately 30%) (Matos et al., 2011). While it is acknowledged that deliberate play, practice and formalised sports training is required to achieve sporting success, safeguarding the welfare of youth players is of paramount importance. Therefore, a review of the predominant youth development programme for soccer is warranted to critique its scientific foundations and identify potential injury risks.

The Elite Player Performance Plan (EPPP): a modern-day example of early sport specialisation

Elite soccer in the United Kingdom (UK) has recently adopted an early sport specialisation approach. Following the introduction of the Elite Player Performance Plan (EPPP, 2011), youth boys participating in such programmes are now required to attend multiple weekly training sessions and competitions, with formal registration commencing at the age of 9 years (EPPP, 2011). This model is based on the theory of 10,000 accumulated practice hours (Gladwell, 2008); a time-frame suggested following observations that performance is gradually improved over time as a result of engaging in extended periods of deliberate practice (Ericson, 1993). In the original UK soccer academy system set out in 1998, the number of required contact hours for coaching was approximately 3,760 (accumulated incrementally from age 9-21) (EPPP, 2011). Under the new regulations set out in the EPPP, this number has been increased to 8,500 contact hours for clubs in the highest academy classification category. Specific requirements for player contact hours as per the EPPP guidance framework are presented in table 1 (EPPP, 2011).

************ Table 1 near here *************

The increased opportunities for training time required in the EPPP are thought to enhance technical proficiency and enable a better progression towards higher levels of performance (EPPP, 2011). Whilst intuitively, accumulating more playing time in a particular sport would appear a valid concept, it should be considered that the original work of Ericsson (1993) has often been incorrectly interpreted (Ericsson, 2013). For example, the observational analysis by Ericsson (1993) identified that not all of the participants accrued the arbitrary 10,000 hours. Four expert violinists averaged only 5,000 hours of deliberate practice; international pianists accumulated in the region of 25,000 hours, and mastery of less competitive activities including memory tasks may require less practice (Ericson and Kintsch, 1995). Additionally, Ericsson

(1993) utilised musicians who perform finite motor skills that may require more specific practice. These tasks are not reflective of the multi-faceted range of technical and physical qualities required for successful performance in soccer; the accumulation of high training hours may be less of a pertinent marker for success in soccer.

The impact of such a significant increase in training volume for young athletes that are experiencing a range of growth and maturational processes is currently unknown. This requires further investigation to determine the potential for injury risk. In the framework of the EPPP, contact hours increase significantly from age 12-16 years coinciding with the peak adolescent growth spurt, which occurs at approximately age 14 years in boys (Malina et al., 2004). This time period may occur earlier in elite youth soccer players due to the high representation of early maturation in elite youth soccer programmes (Malina et al., 2000). The reported risk of injury in youth soccer is also highest during this period, with incidence rising from 8.0 injuries per 1000 hours of exposure in 9-12 year olds, to 65.8 per 100 hours in 13-15 year olds (Rumpf and Cronin, 2012). This concomitant increase in a child's advanced age and greater exposure to training and competition involves high levels of repetitive loading which can increase injury risk (Hogan and Gross, 2003). Further, a linear increase in injury rates has been reported from 9 to 15 years of age in elite male youth players (Price et al., 2004), with a marked increase around the age of 13 years of age (Emery, 2003; Rumpf and Cronin, 2012). Due to rapid growth in skeletal structures, the muscular system must simultaneously develop both in length (to normalize tension from bone growth), and also in size, so that greater levels of force production are possible to support and move the larger and heavier skeleton (Williams et al., 2012). An inherent time lag is present between the rate of bone growth and subsequent muscle lengthening during the growth spurt and around PHV, normalizing to safer ranges during late adolescence. Recent research also shows that elite male youth soccer players experience more traumatic injuries in the year of PHV (van der Sluis et al., 2014), which underlines the greater occurrence of sports injuries in school aged youths with later stages of maturation (Michaud et al., 2001).

Maturational status should also be accounted for in the planning and delivery of training loads during key periods of growth and development. Recent data indicate that later-maturing youth soccer players demonstrate significantly greater injury incidence than those who are early maturers in both the year prior to (3.53 vs. 0.49 overuse injuries/1000 h of exposure) and year of (3.97 vs.1.56 overuse injuries/1000 h of exposure) PHV (van der Sluis et al., 2015). This may be due to increased levels of exposure, and a lack of physical readiness (Carter and Michelli, 2011) and highlights that children participating in organised sports competition in the circa-PHV age group are at a greater risk of certain types of injury. Therefore, the subsequent volume of repetitive movements should be reduced during such periods due to a disproportionate growth of skeletal and muscle tissue, and changes in neuromuscular functioning (De Ste Croix and Deighan, 2012). Enforcing training and match loads on players who are not physically able to withstand the repeated stressors will likely increase injury risk. Further, a structure should be included which is relative to the maturity levels, technical competency and training age of each individual player to minimise injury risk and maximise their long-term athlete development. This is especially true for players in the year prior to and during their maximal accelerated growth spurt ((van der Sluis et al., 2014). Clear guidelines and provision for this are not currently included in the EPPP which suggests a linear increase in training volume during this period. While currently no published research is available to report injury incidence since the inception of the EPPP, this requires further investigation. Practitioners should also consider frequently monitoring the rates of growth and maturation of individual players approximately every three months (Lloyd et al., 2014) and adapting the volume loads of their players accordingly.

The required participation hours each week set out in the EPPP relate only to on-pitch time (structured training and competitions), and no provision or recommendations have been included for athletic development activities which are required in addition to the accumulation of the designated soccer hours (EPPP, 2011). This adds further training loads to youth players involved in such programmes who may also be participating in additional sports at school and has connotations for the development of overuse injuries. A more effective approach may be to place greater emphasis on quality practice in a range of learning environments, and the inclusion of activities which target strength and motor skill development from a young age (Myer et al., 2011) as opposed to simply the accumulation of more sport-specific training hours. An example is integrative neuromuscular training (INT) which consists of exercises to enhance fundamental movement skills, muscular power, lower body and core strength (Myer et al., 2011). The inclusion of preparatory conditioning is essential and can assist in the reduction of injuries. In adolescent athletes, available literature has shown the effectiveness of strength training and movement preparation programmes in decreasing injuries and enhancing recovery times during rehabilitation (Hejna et al., 1982), in lowering the occurrence of both overuse injuries (Soligard et al., 2008) and in decreasing acute trauma (Emery and Meeuwisse, 2010). Targeted interventions which address prevalent risk factors associated with youth sports participation may reduce overuse injuries by approximately 50% in youth athletes (Micheli et al., 2013). Regular participation in varied strength and conditioning programmes that are developmentally appropriate, technique driven, safe and enjoyable has also recently been recommended for youth athletes (Bergeron et al., 2015).

Opportunities to enhance fundamental movement skills during developmental years are also deemed critical due to the accelerated periods of neural plasticity resulting from the natural development of the neuromuscular system (Borms, 1986). This supports the notion of early engagement and variety in athletic development and sporting activities. Importantly for developmental athletes, such preparatory conditioning programmes aimed at youth athletes, still affords the opportunity for children to create exercises, optimising engagement while enhancing physical performance (Faigenbaum et al., 2015). Thus, while the integration of deliberate play which is characterised by sporting activities that are unstructured, play like and enjoyable is recommended (Berry et al., 208), practitioners should also adopt a strategy of deliberate preparation. This approach includes planned training and qualified instruction to enhance athletic skill competency and prevent the accumulation of neuromuscular deficits during the developmental years (Faigenabum et al., in press) that can develop as a result of soccer training and competitions (Atkins et al., 2013; Danshjoo et al., 2013). Furthermore, a recent systematic review demonstrated that participation in neuromuscular type training activities was not a cause for dropout, whereas, a perceived lack of physical competence was (Crane and Temple, 2015). Guidelines are required within the framework of the EPPP to demonstrate more clearly the interaction between technical and physical development sessions to ensure effective implementation and appropriate dosage as part of the holistic development of young soccer players.

While the authors acknowledge that the EPPP is only reflective of a single model from the United Kingdom, based on the available evidence, it is suggested that a range of modifications and provisions should be included within the framework of future long-term athletic development programmes for youth soccer players. These recommendations are outlined below and are designed to enhance the potential for future success and to reduce the risk of traumatic and overuse injuries.

1. Adjustment of the age for which formalised soccer registration is permitted. Specifically, the entry age into formalised academy soccer programmes may be most beneficial after age 12 years and deliberate play should be emphasised prior to this point.
2. Limiting frequent specialised practice sessions (<4 x p/wk) and providing variation and diversity in physical activity and sports is essential in the early years of a child's development to avoid risks of morphological abnormalities.
3. Provisions should be included to monitor and reduce soccer training workloads and increase exposure to neuromuscular training during periods of rapid growth with a particular focus around the time of peak height velocity, especially for late maturers.
4. The ratio of organised sports versus free play time should be <2:1 to reduce the risk of serious overuse injury and at no time should a training threshold of >16 hours of organised soccer and supplemental sports training be completed per week.
5. Guidelines should be included in the framework of long-term soccer development plans to account for the provision of physical development activities that are age-appropriate to assist in the reduction of injury risk and ensure effective integration with all other programme components.

PERSPECTIVES

Limited data is available to support the application of structured early specialisation programmes in the development of soccer players who attain elite status later in life. Conversely, in a wide range of sports a more diverse approach to sports participation appears to be associated with heightened adult performances. Intense participation in a single sport such as soccer prior to physical maturation may also increase the risk of overuse injury. Although data is currently unavailable to report the incidence of injury since the inception of early specialisation programmes such as the EPPP, further investigation is warranted to determine both its effectiveness and the potential injury risks associated with the marked increase in required training volume. Modifications to the existing EPPP framework should also be considered for future long-term athletic development programmes for youth soccer players.

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